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SOURCE Mekhanizatsiya trudoyemkikh i tvazhelykh rabot, No 1, 1950.PLANS FOR SUPERHEAVY DUMP-TRUCK SERIES

A. A. Dushkevich

One of the current problems in mechanization is to put into operation dump trucks with capacities up to 50 tons and self-unloading trailers and semi-trailers with effective load capacities up to 120 tons, capable of traveling over roadless terrain. These new types of trucks can be used most extensively at open-pit mines and construction works such as the building of canals, dams, and airports, and in many other operations where trucks are loaded by excavators. In addition, these superheavy trucks may serve as a basis for the building of powerful large-freight truck trains with effective load capacities of 150 tons and more, as well as heavy truck tractors for hauling especially heavy loads which cannot be broken up.

The automobile and tractor industry must design an integrated family of dump trucks of high load capacity, and modify these to provide special types of self-unloading truck trains for open-pit mines and construction works involving huge volumes of earth. Table 1 gives the basic characteristics of several models of dump trucks (4 x 2 type) and, for comparison, analogous data on the MAZ-205, which has a load capacity of 5 tons.

Table 1

Two-Axle Dump Truck With One Driving Axle

<u>Characteristic</u>	<u>MAZ-205</u>	<u>Others</u>		
Effective load capacity (tons)	5.0	13.5	20.0	27.0
Weight of vehicle (tons)	6.5	14.0	19.0	23.0
Power of engine (hp)	110	200-275	275-295	275-340

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Table 1 (Contd)

<u>Characteristic</u>	<u>Two-Axle Dump Truck With One Driving Axle</u>			
	<u>MAZ-205</u>	<u>Others</u>		
Approximate body volume (cu m)	3.9	7.4	11.3	14.5
Maximum speed (km/hr)	55	50	45	35

Dump trucks with greater load capacities are built on three-axle chassis with two rear driving axles (6 x 4 type), or as truck tractors with dump semi-trailers of the tilting or bunker type. Table 2 gives the characteristics of several such trucks.

Table 2

<u>Characteristic</u>	<u>Self-Unloading Truck Train</u>			
	<u>Three-Axle Dump Truck With Two Driving Axles</u>	<u>Two-Axle Truck Tractor with One-Axle Semi-Trailer</u>	<u>Three-Axle Truck Tractor With Two-Axle Semi-Trailer</u>	
Effective load capacity (tons)	27	36	35	45
Weight of vehicle (tons)	23	36	26	30
Power of engine (hp)	275-340	550	275-340	295-340
Maximum speed (km/hr)	50	32	40	50

The best integrated family of dump trucks with respect to type would consist of a two-axle dump truck with one driving axle, a three-axle truck with two driving axles, and a three-axle truck tractor with a self-unloading semi-trailer. Powerful truck tractors, built on the chassis of such superheavy trucks, make possible the formation of truck trains with extremely high load capacities, which may be used for the most diverse types of operations. Such trains consist of a semitrailer and a bunker-type trailer.

Experience shows that in open-pit operations it is best to use two- or three-axle dump trucks with load capacities of 25-50 tons. The use of 5- to 10 ton trucks in such a case is not economical because too many trucks and personnel are required, jamming the loading area. The basic loading machine used in such operations is the excavator produced by the Sverdlovsk Ural Machine-Building Plant, which has a scoop of 5 cubic meters and, therefore, makes the use of a 10-ton truck almost impossible. It is also difficult to use truck tractors because of the nature of the roads, which must be temporary in view of the constantly changing conditions of operation. Self-unloading truck trains are used mainly where there are great loads of earth to be removed, or for transport of ores from mining areas to railroad centers, harbors, and other bases. Table 3 contains the technical specifications of types of dump trucks with high load capacities, basic characteristics of some of which were given in Table 1.

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Table 3

Effective Load Capacity (tons)

<u>Characteristic</u>	<u>13.5</u>	<u>20.0</u>	<u>27.0</u>	<u>35.0</u>
Wheel arrangement		4 x 2		4 x 2 + 2*
Maximum weight on the axle (tons)	21.0	28.0	33.5	27.5
Tire measurements (in)				
Front	14.00--24	14.00--24	18.00--32	14.00--24
Rear	16.00--24	18.00--24	18.00--32	27.00--33
Gear ratio of main transmission	19.4	17.93	13.52	31.52
Wheel base (mm)	3,800	4,200	4,860	3,350 - 8,350
Length (mm)	6,800	7,950	8,060	14,750
Height (mm)	3,250	3,575	3,675	3,500
Width (mm)	3,100	3,330	3,390	3,540
Clearance (mm)				
Front axle	380	420	650	420
Rear axle	406	412	514	700
Height of body with load (mm)	2,475	2,730	3,125	3,000
Turning radius (meters)	8.2	9.65	10.35	10.0

* Two-axle truck tractor with one-axle trailer

The main requisites for dump trucks with high load capacities are great strength of body to sustain loading by excavators with scoops having volumes of 3 to 6 cubic meters, the ability to pass over very uneven roads without hard surfacing, and a small turning radius. It must be noted that two-axle dump tractors with load capacities of more than 12-15 tons do not have suspension springs on the rear axle.

Dump trucks having high load capacities are equal to ZIS-5, ZIS-150, and GAZ-51 trucks as far as traction power is concerned. The dynamic factor on direct drive in high-capacity trucks lies between 0.05 and 0.06, i.e., there is an available traction of 50-60 kilograms per ton of total truck weight. Although they have a maximum power of 6-7 horsepower and a fuel consumption of 0.4 liter per ton of vehicle weight, they obtain their traction power through a high gear ratio in the main transmission of the rear axle and the reduction of maximum speed to 35-50 kilometers per hour. The grade that can be taken by these vehicles in lowest gear reaches 38 percent. This allows them to overcome the inclines of any ordinary dirt road. Superheavy truck trains have a specific power of 3-5 horsepower per ton of vehicle weight and a fuel consumption of not less than 0.3 liter per ton of truck and trailer weight, with trailers weighing not less than 40 percent of the train.

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The proper choice of tires with respect to type and dimensions is one of the most decisive factors in the case of superheavy trucks with normal chassis arrangement, i.e., without front driving wheels. Loads reaching 8,000 kilograms have brought about a need for low-pressure tires and tubes. Superheavy trucks designed for use on hard dirt roads use tires with the following dimensions: 16.00 x 24, 18.00 x 24; and 18.00 x 32, with an outside diameter up to 2,200 millimeters and a cross section width of 450 millimeters.

The tires are grooved with various designs to insure low pressure on different kinds of terrain and a good grip on the road. Dump and tractor trucks with self-unloading trailers, used on soft dirt or sandy roads are equipped with single tires on the driving and trailer axles of dimensions 27.00 x 33, i.e., an outside diameter of 2,200 millimeters and a cross-sectional width of 685 millimeters. The large dimensions of tires of superheavy trucks also ensure large clearance under the axles -- 400-650 millimeters -- whereas the clearance of the MAZ-205 dump truck does not exceed 290 millimeters.

The best way to improve maneuverability is to reduce the wheel base to the minimum. For example, the wheel base of the 20-ton dump truck is 4,200 millimeters, a little over that of the ZIS-150 truck, whose load capacity is 3.5 tons.

The following trucks are possible future types of dump trucks and self-unloading truck trains with particularly high load capacities:

1. A two-axle dump truck, with one driving axle and a load capacity of 15 tons, designed for general-purpose operations. Its short wheel base insures high maneuverability, and its spring-mounted chassis and powerful motor permit relatively long trips at high speed. Both axles may be driving axles when road conditions are particularly difficult.
2. A three-axle dump truck with two driving axles, with a load capacity of 30 tons; it is designed for the same type of operations as the one described above, and parts for the two are interchangeable. This truck may be the basis for a truck-tractor train for hauling particularly heavy freight which cannot be broken up (boilers, transformers, etc.).
3. A self-unloading truck train consisting of a three-axle truck tractor based on the 30-ton dump truck and a general-purpose, dump, bunker-type semitrailer with a 50-ton load capacity. It has standard tires and is intended for long hauls of loose freight (coal, mineral ores, etc.) over dirt roads; its maximum speed is 50 kilometers per hour; its design is coordinated with that of the 30-ton dump truck.
4. A two-axle dump truck with one driving axle, with a load capacity of 25 tons, intended for operations at open-pit mines where the excavators have 2- to 4- cubic-meter scoops. This truck is used for short hauls; its high load capacity is coupled with a high degree of maneuverability. Only its front axle is mounted on springs and therefore its speed is limited to 30-35 kilometers per hour.
5. A three-axle dump truck with two driving axles and a 45- to 50-ton load capacity. Its parts are fully interchangeable with the preceding truck and it is intended for open-pit work and transport of the heaviest types of mineral ores, loaded by 5- to 10-cubic-meter excavators.
6. A self-unloading truck train, consisting of a two-axle truck tractor based on the 25-ton dump truck and a special dump semitrailer, with a 45-ton load capacity. It is intended for use on soft terrain and therefore runs on single tires of particularly large cross section and diameter; it can be used on various labor-consuming operations involving huge earth loads, such as the

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building of canals, dams, and airfields. Since one of its axles is not mounted on springs, its speed is limited to 30-35 kilometers per hour; its small height permits the loading of earth not only by means of excavators but also by calbe and scraper conveyers, or from bunkers.

Thus, future types of dump trucks and self-unloading trains with high load capacities must fall into two unified categories, one for universal and the other for specialized use. Three-axle dump trucks with 10-ton load capacities may be used until the universal type begins to roll off production lines. The two-axle dump truck with a load capacity of 25 tons will be the basic type in Soviet open-pit operations; and the self-unloading truck tractor based on it, with its 45-ton-capacity trailer, will be the basic type for earth hauling.

Table 4 shows the basic operational requisites for the future types of dump trucks as indicated above.

Table 4

Type of Dump Truck	Effec- ive Load (tons)	Max Full Wt (tons)	Speed (km/hr)		Dynamic Factor on Direct Trans- mission (not less than)	Turning Radius in Meters (not more than)
			High Gear (not less than)	Low Gear (not more than)		
1	15	28	50	1.5	0.075	8.5
2	30	52	50	1.5	0.065	12.0
3	50	80	50	4.0	0.045	14.0
4	25	48	35	2.5	0.065	10.5
5	45	80	35	2.5	0.065	12.0
6	45	75	40	4.0	0.045	12.0

In the future, in addition to the above categories of dump trucks, more powerful self-unloading truck trains with 80- to 100-ton capacities may be designed as the need arises. They may be:

a. A self-unloading truck train consisting of a three-axle truck tractor based on the chassis of the three-axle 45-ton dump truck and a special trailer with a 90-ton load capacity. This combination, like the truck train described in Paragraph 4, will be used on soft terrain and will run on single tires of particularly large cross section and diameter. It will be used in conjunction with excavators having 15- to 20-cubic-meter scoops.

b. A self-unloading truck train with a 90-ton load capacity consisting of a three-axle truck tractor, a universal bunker-type trailer, and semitrailer. It will be designed for the same type of operations as the truck train described in Paragraph 3, with which its parts will be fully interchangeable, except that it will have a more powerful engine. The total weight of such truck trains will be 130-135 tons and the speed 30-40 kilometers per hour.

To provide dump trucks having a particularly high load capacity with efficient motors, a new category of engines of 300-600 horsepower must be designed. Such engines will be valuable in railroad and water transportation,

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as well as in other branches of the national economy. In designing such engines, the possibilities of raising the power derived per liter of cylinder displacement through the use of turbocompressor superchargers must be taken into account. This would permit the use of less powerful engines for more difficult operations, thereby reducing fuel consumption. When necessary, the supercharger can obtain a 50-60 percent increase in engine power.

It is quite possible that in the future gas-turbine motors will be used; these will simplify the power transmission in trucks considerably, reduce the weight of the vehicles, and make the driving and servicing of trucks easier. The elimination of water cooling and the possibility of using a lower grade of fuel are also advantages to be derived from this type of motor. The transmission of trucks with high load capacity should have a hydrodynamic coupling between the motor and the gear box. The gear box must be equipped with synchronizers.

To raise the road performance of the driving axles, trucks should be equipped with automatic blocking differentials or differentials whose gears engage under pressure. The high gear ratios of the main transmission -- in certain cases as high as 30:1 -- require a driving axle with double reduction gears in order to get more axle clearance. In view of the large load on the front axles (up to 16 tons), the steering mechanism must be equipped with hydraulic or pneumatic boosters. For particularly heavy three-axle trucks and truck tractors, an attachment must be devised for the automatic braking of rear driving wheels during turns.

The brake mechanism, wheel hubs, bearings, wheels, and tires of dump trailers are now being standardized with the corresponding parts in truck tractors.

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